Characterizing local upland rice cultivars for on-farm crop diagnosis in northern Thailand

The problem

- In Southeast Asia, swidden cultivation of upland rice (UR) is still an important component of remote montane farming systems. In such still poorly researched systems, UR yields are generally low (1-1.5 t ha^{-1}) and extremely variable.
- Prior to looking for ways to improve these UR cropping systems, more in-depth knowledge on potentials of UR cultivars and factors/conditions limiting UR yields in actual farming situations is required.

Research objectives

- To assess key characteristics of local UR planting material.
- To construct an empirical model of yield buildup processes of the UR crop to be used for on-farm crop diagnosis of limiting factors.

The on-farm diagnostic survey approach

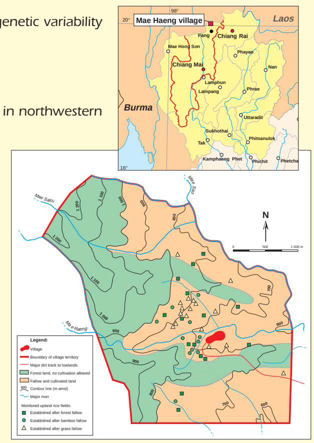
Monitoring squares in UR field.

- A 4-year (1993-96) on-farm survey on the extent and causes of UR yield variability was conducted.
- Data on crop physiological parameters and yield components were obtained through intensive monitoring of 432 squares (1 m^2 each) in 63 farmers' fields.
- An isozyme analysis assessed the genetic variability of farmers' UR cultivars.

The study site

Mae Haeng, a highland Lahu village in northwestern Thailand, is characterized by:

- A monsoon climate, a strong relief, deep granitic soils of medium chemical fertility, and heterogeneous (2- to 10-year-old) types of fallow vegetation,
- Farming systems at an early stage of diversification and still mainly based on the subsistence cultivation of upland rice,
- Traditional swidden cultivation practices in UR and no-input cropping systems with gradually diversifying weed control practices (hoe-tillage and NaCl application).



Map of Mae Haeng study site in Chiang Mai province, upper northern Thailand.

Key genetic and physiological characteristics of upland rice planting material

- Farmers grow only local cultivars, belonging to two physiologically different groups, for which yield buildup processes must be studied separately.
- Late-maturing non-glutinous cultivars (the farmers' basic staple) amount to 70–80% of the total UR production.

Physiological and genetic characteristics of local UR cultivars in Mae Haeng, 1993-96WS.

Cultivar	Importance	Varietal group[a]	Photo-periodism	Grain type	DD to PI[b]	DD to harvest
Early maturing						
Chaloina	Common	Tropical japonica	Weakly sensitive	Nonglutinous	650	1340
Kochokai	Rare				800	1400
Chaloïoe	Rare				670	1350
Kochole	Rare				590	1270
Late maturing						
Chaae	Dominant	Tropical japonica	Strongly sensitive	Nonglutinous	1060	1900
Chanoko	Common			Nonglutinous	1060	1910
Chafuma	Common			Glutinous	1000	1860
Chazu	Rare			Nonglutinous	1230	2120
Komu	Rare			Nonglutinous	1150	1960
Chanona	Rare			Nonglutinous	860	1790

[a] Based on isozyme analysis. [b] DD = degree-days (13 °C threshold temperature), PI = panicle initiation.

Guy Trébuil [1,2], Koen Van Keer [3], Chirawat Vejpas [1], Brigitte Courtois [1,2].

(1) International Rice Research Institute
P.O. Box 3127, MCPO
1271 Makati City,
Philippines.

(3) KULeuven
K. Mercierlaan 92,
3001 Leuven,
Belgium.

(2) CIRAD
Centre de coopération internationale
en recherche agronomique pour le développement
BP 5035, 34032 Montpellier,
cedex 1, France.

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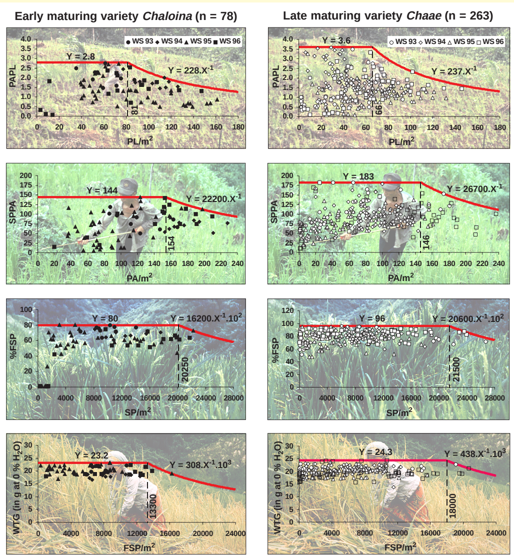
Empirical model of yield buildup processes for the main early and late UR cultivars

- Local UR cultivars displayed yield potentials amounting to 3.1 and 4.4 t ha^{-1} (at 0% H_2O) for early and late cultivars, respectively.



Yield buildup reference curves for Chaloina/early and Chaae/late UR cultivars in Mae Haeng. Pooled data for 1993-96 cropping seasons.

Parameters of the yield buildup reference curves for Chaloina/early and Chaae/late UR cultivars in Mae Haeng. Pooled data for 1993-1996 cropping seasons.

Cultivar	*Chaloina*	*Chaae*
No. of monitoring squares	75	234
Maximum grain yield (g m^{-2} at 0% H_2O)	308	438
Maximum 1000-grain weight (g at 0% H_2O)	23,2	24,3
Threshold value[a] for filled spikelets m^{-2} (no.)	13,300	18,000
Maximum value for filled spikelets m^{-2} (no.)	16,200	20,600
Maximum grain filling (%)	80	96
Threshold value for spikelets m^{-2} (no.)	20,250	21,500
Maximum value for spikelets m^{-2} (no.)	22,200	26,700
Maximum value for spikelets panicle^{-1} (no.)	144	183
Threshold value for panicles m^{-2} (no.)	154	146
Maximum value for panicles m^{-2} (no.)	228	237
Maximum value for panicles plant^{-1} (no.)	2.8	3.6
Threshold value for plants m^{-2} (no.)	81	66

[a] Threshold value = value required to achieve the maximum for a particular yield component

- Data scatters from UR fields support the existence of such yield buildup reference curves, similar to those already established for other cereal crops.
- Yield differentiation between early and late cultivars started at spikelet formation and continued in a cumulative way during the following development phases.
- For both early and late cultivars, yield differentiation occurred mainly during panicle and spikelet formation.

Conclusions

- The inherent yield potential of local cultivars is not a major cause of low UR yields at our study site. Improvements in UR crop management practices could lead to very significant progress in closing the current important yield gap. Consequently, crop management research should dominate the research agenda for such montane UR-based cropping systems.
- This empirical model of UR yield buildup can be applied to identify and to rank the periods of yield differentiation. Subsequently, it will be used to identify and to grade limiting factors of the crop to be alleviated, as well as to conceive, to design and to evaluate improved cropping systems.

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